Report to the Fish and Wildlife Health Committee of the Association of Fish and Wildlife Agencies from USGS Science Centers

September 29, 2010

Wildlife Highlights

White-nose syndrome range expansion in bats, 2009/2010 (CT, MA, NH, NJ, MD, NY, PA, TN, VA, VT, WV, Ontario, Quebec): White-nose syndrome (WNS), a fungal infection of the skin in hibernating bats associated with unprecedented winter mortality in North American bat populations, was confirmed by histology on bats in two new states (Maryland, Tennessee) and two Canadian provinces (Ontario, Quebec) this past winter season. Laboratory-confirmed affected states now total 11 since the disease was first recognized near Albany, New York, in winter 2007/2008, with more than 60 sites involved. Clinical signs of disease continue to occur at confirmed hibernacula in subsequent seasons. In addition, DNA from the fungus *Geomyces destructans*, the presumptive causative agent of WNS, has recently been identified on three new *Myotis* species (*M. grisescens*, *M. velifer*, and *M. austroriparius*) in Missouri, Oklahoma and Virginia, respectively, as well as on female little brown bats arriving at two separate maternity colonies in New Castle County, Delaware. Unusual mortality has not been reported associated with this apparent westward expansion of the fungus, and it remains to be seen if WNS will develop and manifest similarly in warmer climate zones. Current estimates of bat population declines since the emergence of WNS are as high as 97% in some areas. The USGS National Wildlife Health Center, along with many partners, continues to play a primary role in WNS research. The Center distributes Wildlife Health Bulletins on new developments related to WNS and other wildlife health issues. These can be found at http://www.nwhc.usgs.gov. **Contacts:** David Blehert, National Wildlife Health Center, 608-270-2466, dblehert@usgs.gov; Anne Ballmann, 608-270-2445, aballmann@usgs.gov

Genome of *Geomyces destructans:* The Broad Institute of MIT/Harvard received help from USGS NWHC to sequence the genome of *G. destructans*. The Broad Institute recently released the assembly of the *G. destructans* nuclear and mitochondrial genomes on their Web site and also submitted the data to Genbank: <http://www.broadinstitute.org/annotation/genome/Geomyces_destructans/MultiHome.html>
These data will facilitate the identification of virulence determinants of WNS, allow researchers to study the genetic history of the fungus, and provide access to additional genetic markers for the development of improved diagnostic tests. **Contact:** David Blehert, National Wildlife Health Center, 608-270-2466, dblehert@usgs.gov

Recent WNS publications include: White-nose syndrome fungus (*Geomyces destructans*) in bats, Europe. **Emerging Infectious Diseases** 16(8):1237-1242. http://www.cdc.gov/eid/content/16/8/1237.htm, and Rapid polymerase chain reaction diagnosis of white-nose syndrome in bats. **Journal of Veterinary Diagnostic Investigation** 22(2):224-230.
http://www.nwhc.usgs.gov/disease_information/white-nose_syndrome/vetd-22-02-224-230-e.pdf

Oral baits and biomarkers for plague vaccine delivery to prairie dogs: Laboratory studies at NWHC have demonstrated that oral vaccination of prairie dogs against plague using raccoon pox-vectored vaccine is feasible, resulting in significant protection against challenge with *Yersinia pestis* in both black-tailed and Utah prairie dogs. Studies in Gunnison's and white-tailed prairie dogs are scheduled for next summer. We have also recently selected a field-delivery bait that is palatable to prairie dogs, resistant to environmental conditions, and capable of maintaining vaccine titer, along with an appropriate biomarker to evaluate uptake

by animals. Field studies in Colorado and Utah with baits containing only the biomarker confirmed bait uptake in > 90% of prairie dogs after an application rate of 4 baits per active burrow. These results further validate the feasibility of oral vaccination of prairie dogs against plague and provide all the critical elements needed to move forward with registration of the vaccine and eventual field trials. Registration of the vaccine with USDA is proceeding. **Contact**: Tonie Rocke, National Wildlife Health Center, 608-270-2451, trocke@usgs.gov

H5N1 highly pathogenic avian influenza: The Federal, State and Tribal partnership formed to develop and implement the National Interagency Early Detection System for Highly Pathogenic H5N1 Avian Influenza in Wild Migratory Birds has continued into its third year of surveillance. Birds have been tested from all 50 states and 6 freely-associated states and territories. While the surveillance focused on waterfowl, shorebirds, gulls and terns, a total of 284 species were sampled. So far, during the 2010 sampling year (April 1, 2010 – March 31, 2011), DOI cooperating agencies collected and analyzed over 6,094 wild bird samples and the highly pathogenic avian influenza H5N1 virus was **not** detected. Of these, 110 have tested positive for low pathogenic avian influenza based on molecular screening; 12 were H5 positive, but none were H5N1. **Contact:** Scott Wright, National Wildlife Health Center, 608-270-2460, swright@usgs.gov

Genetic assessment of low pathogenic avian influenza in migratory birds to enhance future surveillance efforts for highly pathogenic avian influenza and other pathogens (U.S.): In collaboration with the National Wildlife Health Center, the U.S. Fish and Wildlife Service, and other state and federal agencies, staff at the Alaska Science Center have examined genomic characteristics of >100 low pathogenic avian influenza (LPAI) virus isolates from over 15 species of migratory birds sampled throughout Alaska. Results demonstrate that species with migratory connectivity to Asia and those sampled closer to Asia, such as in western Alaska, have a greater likelihood of carrying LPAI viruses that contain Asian genes. Thus, both migratory connectivity and geographic proximity to Asian migratory flyways are factors in the spread of LPAI viruses from Asia to Alaska. These factors are likely also important in the potential spread of a highly pathogenic avian influenza virus, such as the Asian H5N1 strain, or other avian pathogens to Alaska. Thus, genetic methods are a useful tool for identifying species and regions to focus future surveillance sampling plans. **Contact:** Dirk Derksen or John Pearce, Alaska Science Center, 907-786-7000, dderksen@usgs.gov or jpearce@usgs.gov

Migratory birds and highly pathogenic avian influenza – Studies from endemic regions of Eurasia: USGS scientists continue working with United Nations Food and Agriculture Organization and international partners in persistent zones of HPAI H5N1 infection in Asia and Africa. The team has studied migratory patterns of 25 waterfowl species from outbreak regions in 11 countries. Regional differences are emerging regarding likelihood of wild bird involvement in HPAI spread as evidenced by concordance between wild bird movements, poultry locations and disease outbreaks. Analysis of movement rates also reveal that while waterfowl are capable of long distance movements within short time frames equal to periods of asymptomatic virus infection, the likelihood of this occurring during migration is low. Updates on program status and risk modeling efforts were presented at the second international workshop on Community-based Data Synthesis, Analysis, and Modeling of HPAI H5N1 held in Beijing in May 2010 (http://www.eomf.ou.edu/workshop/2nd-birdflu/). **Contacts:** Diann Prosser, Patuxent Wildlife Research Center, diann_prosser@usgs.gov; John Takekawa, Western Ecological Research Center john_takekawa@usgs.gov.

West Nile virus: USGS scientists have collaborated with scientists from the University of Rhode Island and from Suffolk County (NY) Department of Health Services to study the transmission ecology of West Nile Virus among birds and mosquitoes, and to develop tools to better predict WNV outbreaks among humans. Recent publications assess feeding preferences of mosquitoes for various species of wild birds, and provide evidence that early summer mosquito surveillance can be used to predict levels of WNV infection in mosquitoes in mid- to late summer, when most human infections are acquired. WNV infection in concurrently

collected mosquitoes and bird blood samples are currently being analyzed to develop models of WNV transmission among mosquitoes and birds in an endemic area in New York. **Contact:** Dr. Howard Ginsberg, Patuxent Wildlife Research Center, 401-874-4537, hginsberg@usgs.gov

Lyme disease: USGS scientists from Patuxent Wildlife Research Center are collaborating with researchers from six universities (Michigan State University, University of Rhode Island, Hofstra University, Georgia Southern University, University of Tennessee, University of Montreal) on an NSF-funded project to determine why Lyme disease is relatively common in the northern U.S., and less common in the south, even though the vector tick, *Ixodes scapularis*, is present in both regions. The first field season involves standardized sampling from northeastern (Massachusetts), north central (Wisconsin), southeastern (South Carolina) and south central (Tennessee) sites to finalize methods and logistics, so as to evaluate the influences of host community factors (vertebrate diversity, relative abundance of lizards), seasonality (effects of phenological differences on transmission efficiency), and tick genetic factors (*I. scapularis* is more genetically diverse in the south than in the north), on the importance of Lyme disease in each region. Sampling will be expanded to additional sites in each region for subsequent sample years. For more information, visit http://wildlifehealth.tennessee.edu/lyme_gradient/index.htm.
Contact: Dr. Howard Ginsberg, Patuxent Wildlife Research Center, 401-874-4537, hginsberg@usgs.gov

Reversion to virulence and efficacy of an attenuated canarypox vaccine in Hawai`i `Amakihi: While vaccines are currently impractical for controlling transmission of *Avipoxvirus* in wild populations, they may be effective tools for protecting small populations of highly susceptible endangered, captive-reared or translocated Hawaiian honeycreepers. We tested whether Hawai'i 'Amakihi (*Hemignathus virens*) can be protected from wild isolates of *Avipoxvirus* from the Hawaiian Islands with an attenuated canarypox vaccine that is genetically similar to one of two passerine isolates from Hawai`i and distinct from Fowlpox. Birds were challenged with either a wild isolate of Fowlpox from Hawai`i, a Hawai`i `Amakihi isolate of a canarypox-like virus (Pox Variant 1) or a Hawai`i `Amakihi isolate of a related, but distinct passerine *Avipoxvirus* (Pox Variant 2). Similar randomly selected groups of unvaccinated 'Amakihi were challenged with the same virus isolates. Vaccinated and unvaccinated 'Amakihi challenged with Fowlpox had transient infections with no clinical signs of infection. Mortality in vaccinated 'Amakihi challenged with Pox Variant 1 and Pox Variant 2 ranged from 0% (0/5) for Pox Variant 1 to 60% (3/5) for Pox Variant 2. Mortality in unvaccinated 'Amakihi ranged from 40% (2/5) for Pox Variant 1 to 100% (5/5) for Pox Variant 2. While the vaccine provided some protection against Pox Variant 1, both potential for vaccine reversion and low efficacy against Pox Variant 2 preclude its use in captive or wild honeycreepers. **Contact:** Carter Atkinson, Pacific Island Ecosystems Research Center, 808-967-8119, catkinson@usgs.gov

Type-E botulism in the Great Lakes: Botulism outbreaks have contributed to die-offs of fish-eating water birds on the Great Lakes and are affecting ecosystem health. USGS is investigating how ecological factors contribute to producing botulism toxin by developing a rapid assay for detection of botulinum neurotoxin type E, characterizing the distribution of foraging waterbirds during botulism outbreaks, evaluating exposure pathways in the aquatic food chain, and identifying physical and biological linkages that drive outbreaks. An understanding of feeding patterns and exposure routes of sentinel waterbird species historically at risk to botulism die-offs, such as the common loon, is also central to assessing pathways of botulism exposure through aquatic food chains in the Great Lakes and identification of physical and biological linkages that drive botulism outbreaks. **Contacts:** Jonathan Sleeman, National Wildlife Health Center, 608-270-2402, jsleeman@usgs.gov and Kevin Kenow, Upper Midwest Environmental Sciences Center, 608-781-6278, kkenow@usgs.gov.

Wildlife Health Event Reporter: The NBII Wildlife Disease Information Node, through its partners at the USGS National Wildlife Health Center, the University of Wisconsin Nelson Institute of Environmental Studies, and HealthMap.org (Children's Hospital Boston), have created an experimental Web application, the

Wildlife Health Event Reporter (WHER), and have added the ability to report wildlife health events via a mobile phone application by HealthMap called *Outbreaks Near Me*. These tools will enhance public assistance in the surveillance of wildlife disease events. Many groups are harnessing the energy of an interested public in "Citizen Science" projects for the purpose of expanding the scope and quantity of timely field observations. In early September, members of the AFWA Fish and Wildlife Health Committee were given details about WHER and its pending public beta release through a letter that can be seen at http://wildlifedisease.nbii.gov/documents/wher/WHER_Letter.pdf . As the result of citizens using WHER and HealthMap's mobile application, resource agencies will be able to assess the benefits of these tools through an increase in observational power that could potentially lead to a better understanding of both baseline and exceptional wildlife disease events. WHER can be accessed at http://www.whmn.org/wher. Individuals can obtain an account and provide feedback by contacting wdin@usgs.gov. **Contact**: Joshua Dein, National Wildlife Health Center, 608-270-2450

Disease Investigations

Virulent Newcastle Disease virus found in double-crested cormorants: Since late July, the USGS National Wildlife Health Center (NWHC) has confirmed that at least 800 double-crested cormorants have died in Minnesota, North Dakota, and Wisconsin from virulent Newcastle Disease virus (vNDV). Ring-billed gulls and American white pelicans have also been found dead in these same areas, but vNDV has not been confirmed as the cause of death. This virus sporadically cycles through nestling and juvenile cormorants in summer nesting colonies. The designation of vNDV indicates that this strain has the potential to cause illness or mortality in poultry, although transmission of wild bird vNDV to poultry is probably rare based on similar historic events. According to the Canadian Cooperative Wildlife Health Centre, Newcastle Disease has also been confirmed in cormorants in Saskatchewan. Further investigations are in progress to assess the extent of the outbreak. NWHC is working with officials from the Minnesota and Wisconsin Departments of Natural Resources, biologists from affected wildlife refuges, USDA APHIS Wildlife and Veterinary Services, USDA National Veterinary Services Laboratories, the Minnesota, North Dakota, and Wisconsin State Veterinarian's offices, and the Canadian Cooperative Wildlife Health Centre to manage the outbreak by reducing possible impacts to wild birds and preventing spread to domestic poultry. **Contact:** LeAnn White, National Wildlife Health Center, 608-270-2491, clwhite@usgs.gov

Puffer fish die-off in Hawaii: The Honolulu Field Station (HFS) of the USGS National Wildlife Health Center is investigating a die-off of striped puffer fish (*Arothron hispidus*) occurring on the islands of Hawaii, Maui, Molokai, Lanai, and Oahu. Mortality has been ongoing since February on the island of Hawaii; March on the island of Maui; and April on the island of Oahu. Affected puffer fish are appearing on the water surface and on shorelines. Fish on the water surface are puffed up, are unable to right themselves, and soon die. HFS became involved in mid-June after being contacted by the Hawaii Institute of Marine Biology. Striped puffer fish are the main species affected (>90%), although rare instances of affected spotted puffer fish (*A. meleagris*) and porcupine puffer fish (*Diodon hystrix*) have been reported. The HFS is working closely with the Hawaii Institute of Marine Biology, Hawaii Division of Aquatic Resources, and members of the public through a community reef watch organization, Eyes of the Reef (EOR). The HFS is also working with Washington University and the USGS Western Fisheries Research Center (WFRC) in Seattle to determine the cause of illness and death. **Contact:** Thierry Work, National Wildlife Health Center–Honolulu Field Station, 808-792-9520, thierry_work@usgs.gov

Ethanol toxicosis and subsequent trauma in cedar waxwings (TX): In March 2010 an estimated 50 cedar waxwings were found dead along a roadside in Harris County, Texas. Due to the proximity of the mortality event to the road, many of the birds had been struck by vehicles and were unsuitable for diagnostic testing. Three immature female cedar waxwings, however, were intact and submitted to the USGS National Wildlife Health Center for testing. Berries from decorative shrubs (the shrub species was not identified but were

thought to be a species of *Ilex*) located near the mortality site were also submitted with the birds. All three birds had evidence of thoracic trauma and berries were observed in their upper digestive tract. Although the berries from the birds were unsuitable for testing, the berries collected from the nearby shrub were found to contain 800 ppm ethanol by wet weight. The level of ethanol found in the berries collected from the mortality event location was high enough to produce intoxication in these birds that could have resulted in compromised behavior and subsequent fatal trauma. Fermented fruit intoxication has been previously reported in several species of birds including robins and cedar waxwings. Fermentation toxicity is most common in late winter and early spring when thawing of overwintered berries allows for yeast fermentation of the sugars in the berries. **Contact:** LeAnn White, National Wildlife Health Center, 608-270-2491, clwhite@usgs.gov

Grebe mortality at San Diego reservoir (CA): Multiple agencies responded to a mortality event of Western and Clark's grebes at Sweetwater Reservoir in San Diego, California. Initial reports indicated more than 250 grebes were known dead with few other species affected. Carcasses were in various states of decomposition; mortality was estimated to have begun around July 1, 2010. Sweetwater Authority officials quickly diverted to other drinking water sources until testing was completed. Examination by USGS National Wildlife Health Center, San Diego County Veterinarian, and California Animal Health and Food Safety Laboratory all revealed severe emaciation on gross examination. Laboratory testing did not identify any bacterial or viral pathogens, parasites, or toxins in tissues or water samples. Mortalities continued throughout July and totaled 600 birds, which comprised about 90% of the resident grebe population. No abnormal situations were noted during field investigations, and no other nearby areas were affected. Fish surveys conducted by California Fish and Game identified schools of shad throughout the lake, and populations were consistent with other similar lakes in southern California. The cause of the mortality event is still undetermined at this time. A substantially larger mortality event involving eared grebes at Salton Sea in 1991-1992 also remains undetermined although the field signs and carcass conditions were not the same in the two events. **Contact:** Krysten Schuler, National Wildlife Health Center, 608-270-2447, kschuler@usgs.gov

Amphibians

Effects of chytrid fungus (*Batriochochytrium dendrobatidis*) on amphibian populations: The chytrid fungus is linked to the worldwide decline and possibly to mass mortality of amphibians. A previous short-term study of one population of treefrogs determined that uninfected animals had higher survival rates than infected ones. USGS scientists and co-authors conducted a similar study over six years in three populations of Rocky Mountain toads. Infected toads had a lower probability of survival than uninfected toads, which suggests that the disease may reduce survival by 31-42% in wild toads. Survival of toads in diseased populations showed a 5-7% decline per year, whereas uninfected populations showed comparatively stable growth. Further, the data suggest that the presence of the fungus does not cause rapid population declines, but it may function as a low-level, chronic disease. Some amphibian populations may be coexisting with the fungus, and the results highlight the importance of assessing survival in diseased amphibian populations. **Contact:** David Pilliod, Forest and Rangeland Ecosystem Science Center, 208-426-5202, dpilliod@usgs.gov

Understanding the distribution of chytrid fungus (OR, WA): Testing individual frogs and toads in a population is a common approach for detecting the presence and frequency of a chytrid fungus (Bd), which has been associated with amphibian declines. This approach may result in false negatives, the failure to detect the pathogen when it is present in individuals or populations. USGS scientists and co-authors report results from applying occupancy models to such data from the Pacific Northwest. The probability of detecting Bd was related to the developmental stage of the animal tested, day of the year, site elevation, and human activities. While widely distributed, Bd was not in every population, and occupancy models suggest this was not purely due to false negatives. The results emphasize the need to understand variation in occurrence and the need to prevent the spread of Bd, even within regions where it is widely distributed. **Contact:** Michael Adams, Forest and Rangeland Ecosystem Science Center, 541-758-8857, mjadams@usgs.gov

Fisheries Highlights

Use of chloramine-T to control mortality associated with bacterial gill disease and external flavobacteriosis on cultured freshwater fish: The USGS's Upper Midwest Environmental Sciences Center (UMESC) developed efficacy, environmental fate, human food safety, and target animal safety data required for the approval of Halamid ® (chloramine-T) to control mortality associated with bacterial gill disease and external flavobacteriosis on cultured freshwater fish. The report, "Validation of modifications made to the method for determining para-toluenesulfonamide (the chloramine-T marker residue) concentrations in freshwater fish fillet tissue" was submitted to the U.S. Food and Drug Administration's Center for Veterinary Medicine (CVM) in September. The report is expected to allow CVM to conclude that the analytical method to quantify para-toluenesulfonamide (p-TSA), the marker residue or chloramine-T administration, is acceptable to quantify p-TSA at concentrations <20 ng/g (parts per billion). The new method, with its lower detection limit (previously it was ~30 ng/g) and ability to eliminate interfering compounds, combined with the residue depletion data previously developed by UMESC and accepted by CVM, should complete the human food safety technical section, which is the last major technical section be completed before chloramine-T may be approved to control disease in fish. **Contact**: Mark Gaikowski, Upper Midwest Environmental Sciences Center, 608-781-6284, mgaikowski@usgs.gov.

Use of hydrogen peroxide (H_2O_2) to control external parasites on fish: In August, the U.S. Food and Drug Administration Center for Veterinary Medicine (CVM) accepted a study completed by USGS's Upper Midwest Environmental Sciences Center (UMESC), U.S. Fish and Wildlife Service's (FWS) Iron River National Fish Hatchery, and FWS La Crosse Fish Health Center (FHC) to evaluate the effectiveness of hydrogen peroxide to control external parasites on fish. The final study report "Confirmation of the efficacy of 35% PEROX-AID to reduce *Gyrodactylus salmonis* infestation density on coaster brook trout *Salvelinus fontinalis*" was accepted as a pivotal study, meaning CVM considered it a well controlled study that establishes an effective concentration to control the parasite. The CVM also accepted another collaborative study between the UMESC, Michigan DNR Marquette State Fish Hatchery and FWS La Crosse FHC to evaluate the effectiveness of hydrogen peroxide to control external parasites on fish. The final study report was accepted as providing supportive evidence of the effectiveness of hydrogen peroxide to control external parasites of fish. The CVM concluded after accepting these studies that the completion of one additional pivotal study to control a *Gyrodactylus* sp. in a trout species other than brook trout, combined with evidence that all *Gyrodactylus* sp. are expected to respond similarly to hydrogen peroxide, would complete the effectiveness technical section for the use of 35% PEROX-AID to control *Gyrodactylus salmonis* in freshwater-reared salmonids. Completing the effectiveness technical section would enable the drug sponsor, Eka Chemicals, Inc., to amend their drug label and would allow hatchery managers to control a broad group of external parasites causing disease in freshwater-reared fish. **Contact:** Mark Gaikowski, Upper Midwest Environmental Sciences Center, 608-781-6284, mgaikowski@usgs.gov**.**

Emergence of infectious hematopoietic necrosis virus in hatchery and wild steelhead on the Olympic Peninsula of Washington: In recent years, there has been an emergence of a new strain of infectious hematopoietic necrosis virus (IHNV) that is threatening Federal, State and Tribal steelhead and rainbow trout populations in river basins on the Olympic Peninsula and Puget Sound in Washington State. The M-D strain of the virus differs from the strains of IHNV that are common among sockeye throughout the Washington coast and Puget Sound in that it is highly lethal to steelhead and rainbow trout. Genetic typing has been used to provide data about the epidemiology and evolution of the virus, how it moves within and between watersheds, and how it is changing over time. This molecular epidemiology has revealed that identical isolates of the virus are present among steelhead reared at certain large federal hatcheries in the Columbia River and that these fish may be a source of the virus found in steelhead on the Washington coast. Ongoing work will continue to involve typing of field isolates and wet-lab experiments to explore components of viral

transmission like animal density, viral shedding, and water temperature. **Contact**: Gael Kurath, Western Fisheries Research Center, 206-526-6583, gkurath@usgs.gov.

Continued spread of viral hemorrhagic septicemia virus: As of the fall 2010, viral hemorrhagic septicemia virus (VHSV) has been isolated from more than 25 species of fish in Lake Superior, Lake Michigan, Lake Huron, Lake St. Clair, Lake Erie, Lake Ontario, the Saint Lawrence River and from inland lakes in New York, Michigan, Wisconsin and Ohio. The Great Lakes strain of VHSV has an exceptionally broad host range and significant mortality has occurred in muskellunge, freshwater drum, yellow perch, round goby, emerald shiners and gizzard shad. Surveillance activities by federal, state, tribal and private sector entities have increased in the region and movement restrictions have been implemented; however, the virus was found in fish from an Ohio reservoir connected to the Mississippi River drainage. Currently, researchers at the WFRC have completed work on a VHSV sequence database that includes sequence analysis of more than 100 isolates. The database will provide important epidemiological insights about changes in the host or geographic range, virulence and translocation of the virus as it emerges in the Great Lakes system. **Contact:** Gael Kurath, Western Fisheries Research Center, 206-526-6583, gkurath@usgs.gov.

Warming climate can affect fish health: Reports from subsistence fishermen and tribal elders indicate the emergence of *Ichthyophonus* infections in adult Chinook salmon returning to the Yukon River in Alaska that are associated with adverse flesh quality and possible pre-spawning losses. Clinical signs of disease are minimal when fish enter the river, but increase significantly when fish reach the middle river. Elevated river temperatures in recent decades are postulated to be an important cause of the emergence and increased severity of the disease. To understand the role of temperature on the disease process, infected and control groups of rainbow trout were held at 10, 15 and 20°C for 28 days to monitor mortality and disease progression. Infected fish demonstrated more rapid onset of disease, higher parasite load and a faster death rate at higher temperature. In a second experiment to determine the role of temperature on the swimming stamina of *Ichthyophonus*-infected fish, infected trout were reared at 15°C for 16 weeks before being subjected to forced swimming at 10, 15 and 20°C. Stamina was significantly impaired in infected fish as temperature increased. This study highlights the role of environmental stressors, such as climate change, on the ecology of fish diseases as well as the impact of these diseases on fitness traits important to the survival of natural populations. **Contact:** Jim Winton, Western Fisheries Research Center, 206-526-6587, jwinton@usgs.gov.

Effects of endocrine disrupters and contaminants on the fish immune system: A zebrafish model has been developed that can be used to investigate the molecular mechanisms and pathways affected by early exposure to contaminants and endocrine disrupting compounds and to compare the immune function and resistance to viral and bacterial pathogens in fish exposed to these compounds relative to controls. Initial studies used groups of zebrafish exposed to cadmium at environmentally relevant doses and examined pathological effects of exposure as well as innate immune gene expression in groups of fish exposed to cadmium and given an immunostimulant. To gain an understanding of the effect on contaminant exposure to expression of key immune genes and the pathways affected, samples of kidney and spleen tissues were collected and the total RNA isolated. This will be amplified, labeled and hybridized to Agilent zebrafish microarrays that can measure expression levels of 44,000 genes. Bioinformatic analysis will show specific immune system genes and pathways affected by exposure to contaminants and/or by immune stimulation. **Contact:** John Hansen, Western Fisheries Research Center, 206-526-6588, jhansen@usgs.gov

Investigation of contaminants in feeds and fish at FWS Pacific Region National Fish Hatcheries and the ramifications to human and ecological health: The WFRC Columbia River Research Laboratory is working with the US Fish & Wildlife Service to determine the degree to which contaminants in fish feed bioaccumulate in Pacific salmon, and the subsequent effects on salmon released from hatcheries as smolts. Contaminants can enter fish feed from a variety of sources, but generally reflect global contaminant inputs into oceans and marine food webs. Well-fed hatchery fish will accumulate lipophilic organochlorines (OCs)

(e.g., PCBs, dioxins and furans) in fat depots where the toxic effects are muted. When fish stop feeding, however, the lipids are mobilized as an energy source and OCs are redeposited in vital organs (e.g., brain, liver, heart, kidney). Upon release from a hatchery as smolts, Pacific salmon may not feed as they adapt to new foods available in the wild. In this study, we collected feed and fish tissue from three hatcheries rearing steelhead, spring Chinook and coho salmon, and assayed these for a wide range of contaminants. To examine the impacts of redistribution of contaminants after fish were released, groups of fish from each hatchery and were held back and either fed or fasted. After 14 and 21 days, fish were sampled and their brains, livers and carcasses were assayed for contaminants, and gene expression in livers was assessed using a cDNA. The results of these assays will be used to develop hypotheses as to the physiological systems affected by the contaminants. **Contact**: Alec G. Maule, WFRC, Columbia River Research Lab; 509-538-2299 x 239; amaule@usgs.gov.

Contaminants Highlights

Evaluating potential contaminant threats in the Klamath Basin (OR, CA): The competing agricultural, ecological, and cultural needs in the Klamath Basin, which spans the Oregon-California border, are of national interest. Recently, federal, state, and local stakeholders have agreed to cooperate on large-scale restoration actions to restore fish populations and establish reliable water supplies. Some planned restoration activities, such as dam removal, will change the hydrology of the Basin, which is already limited in water quantity and quality. Further, these changes may influence the cycling, fate, and movement of contaminants in the Basin and result in unintended consequences. Contaminant sources include large-scale agriculture, past mining efforts, algal toxins, and waste water treatment plants. Scientists at the Forest and Rangeland Ecosystem Science Center will initiate a new study to systematically evaluate the potential threats of various contaminants. **Contact:** Collin Eagles-Smith, Forest and Rangeland Ecosystem Science Center, 541-750-0949, ceagles-smith@usgs.gov

Mercury levels related to improper hatching positions in bird embryos (CA): Mercury is a widespread contaminant that impairs avian reproductive success and egg hatchability, but the mechanisms are not well understood. USGS scientists at FRESC and a collaborator from the University of California-Davis published a recent study that may help explain some of these mechanisms. Bird embryos need to be properly positioned within the egg in order to successfully hatch. The researchers examined the embryo positioning in eggs of three waterbird species from San Francisco Bay and found a relatively high rate of chick malpositions, especially in eggs that failed to hatch. In Forster's terns, the species previously shown to be at greatest risk for mercury effects, the likelihood of malpositions was significantly related to mercury concentrations in eggs. The specific mechanisms for mercury-induced malpositions require further study, but may be the result of reduced egg turning and other altered behaviors in adult birds with elevated mercury levels. **Contact**: Collin Eagles-Smith, Forest and Rangeland Ecosystem Science Center, 541-750-0949, ceagles-smith@usgs.gov

California condor feathers elucidate lead exposure history (CA): Currently listed as an endangered species, California condors are scavengers, and previous studies have indicated that lead poisoning from ammunition fragments in animal carcasses is a factor limiting their survival and recovery. USGS scientists collaborated on a study to investigate whether sampling feathers from free-flying condors is an effective method for establishing their lead-exposure history. The feather analysis identified exposure events that were not evident from blood samples, and was useful for estimating when specific exposures occurred. The findings may increase the understanding of population-level effects of lead poisoning in condors and may be helpful for other avian species**. Contact**: J. Matthew Johnson, Forest and Rangeland Ecosystem Science Center, 541-750-0951, matthew_johnson@usgs.gov

Birds as indicators of contaminant exposure and effects in the Great Lakes: Historical (e.g., organochlorine insecticides, polychlorinated biphenyls, dioxins, mercury, polycyclic aromatic hydrocarbons)

and newly emerging contaminants (e.g., perfluorinated compounds and flame retardants) are distributed throughout the Great Lakes and are found at exceptionally high levels at some Areas of Concern. Exposure to these contaminants may have adverse effects on food webs and the survival and metabolism of animals and invertebrates. USGS scientists at the Upper Midwest Environmental Sciences Center are using funding through the Great Lakes Restoration Initiative to sample birds (tree swallows and certain waterbirds) at about two dozen sites as indicators of chemical exposure and effects in the Great Lakes. Changes in chemical residues and biological indicators in avian samples are being used to interpret the success of remediation activities already completed or in progress, and will assist in the prioritization of sites that are being considered for future remediation. The exposure and effect studies will provide important data for EPA and other regulators to use in determining the degree of impairments to each site, such as adverse impacts to fish and wildlife populations and whether those sites can be delisted or will require additional treatment.
Contact: Thomas W. Custer, Upper Midwest Environmental Sciences Center, 608-781-6375, tcuster@usgs.gov.